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Original Research Article

Effect of Different Spacings on Flowering, Yield and Quality of Lima Bean (*Phaseolus lunatus* L.)

Sweta Gawande*, Ekta Ningot, Chanchal Nikam and Madhavi Bhaladhare

Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth,
Akola-444104 (Maharashtra), India
**Corresponding author*

Keywords

Lima bean, Flowering, Spacing, Yield seed protein

A B S T R A C T

A field experiment was conducted at the Main Garden, Department of Horticulture, Dr. P.D.K.V. Akola. During 2015-2016 to study the effect of different spacing on growth, yield and quality of lima bean. The experiment was laid out in RBD with seven plant spacing as treatment replicate thrice. The results revealed that all the flowering and yield parameters were significantly influenced by various plant spacing. The flowering parameters like days to first flowering, days to 50% flowering, inflorescence per plant and flowers per inflorescence was significantly superior in the plant spacing S_3 that is 1.0 x 0.75m. The yield and yield contributing parameters were found to be significantly superior in the plant spacing of 1.0m x 0.75m. Quality parameter seed protein content was observed non-significant.

Introduction

Lima bean (*Phaseolus lunatus* L) is a legume plus protein rich crop, which belongs to popular plant family Leguminaceae. It is originated in or near Guatemala (Choudhary, 2006). It is native of Central America, now widely naturalised in the tropics and is also known by the names of butter bean or double bean.

It is found in humid, sub-humid and semi-arid tropical climate as well as warm temperate climate. There are wild and cultivated types of *Phaseolus lunatus*, generally referred to as *Phaseolus lunatus* var. silvester Baudet and *P. lunatus* var. lunatus respectively. Lima beans sprouts, leaves, young pods and green seeds are edible and eaten as vegetables.

Lima beans are tender annuals grown for their flat, crescent oval shaped seeds. There are two types of lima beans; bush and pole or vine varieties. Bush types grow to about two feet tall and tend to have smaller seeds; they bear more quickly than pole lima bean varieties. Pole lima beans have large seeds and can grow 10 to 12 feet high. Small-seeded limas, usually bush types are also called butter beans, sieve beans, Burma beans, Madagascar beans, Carolina beans and “baby limas”. Large seeded lima beans are sometimes called potato limas. Lima beans have pale green pods that vary from 3-4 inches long to 5-8 inches long depending upon variety. Lima bean seeds are eaten, not the pods. Leaves are commonly composed of three leaflets and the flowers are white.

Bush lima bean varieties are ready for harvest from 60 to 80 days from sowing while pole lima bean varieties are ready for harvest in 85 to 90 days. Lima beans are very nutritious beans, high in protein, thiamine, riboflavin and iron. They contain about 25% protein in the dry matter, a value comparable to that of peas and cowpeas (Baudoin, 2006). However, very less systematic work has been carried out on production technology of this minor legume crop. Research on the impact of cropping practices on profitability is lacking and is needed to implement changes to make production more profitable and maintain lima bean as a viable crop in this region. Good agronomic practices such as spacing, time of sowing and fertilizer application have been associated to high biological and economic yield (Onwueme, 1990). Spacing is required to ensure proper utilization of inputs like nutrients, moisture and light resulting in better production performance of the plant. Also maximum yield could be obtained mainly by providing the most optimum plant population per unit area (Shrikanth *et al.*, 2008).

Materials and Methods

The present study entitled "Effect of different spacings on growth and yield of lima bean (*Phaseolus lunatus* L.)" was carried out at Main Garden, University Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during the *Kharif* season of 2015-16. The experiment consisted of seven different plant spacings to study the effect of these spacings on growth, yield and quality of lima bean. The topography of the land under experiment was fairly uniform. Soil of the experimental plot was medium black, well drained with uniform texture with gentle slope. Lima bean cv, AKLB-2 is a high yielding variety recommended for vidarbha region of Maharashtra. This variety developed by Dr. PDKV Akola with high yielder and earliness with good yield potential. AKLB-2 is a tender annual grown for their large flat, crescent, oval shaped seeds with pod length of 7-8cm. Observations were recorded on flowering parameters like days to first flowering, days to 50% flowering, inflorescence per plant and flowers per inflorescence. And yield parameters like number of pods per cluster, length of pod (cm), width of pod (cm), weight of dry seed (g), weight of dry seed per pod (g), weight of 100 dry seeds (g) seed yield per plant (g) and seed yield per hectare and seed protein content at the time of flowering and yield and collected data were statistically analyzed as per method suggested by Pansey and Sukhatme (1985).

Results and Discussion

The data regarding flowering, yield and quality parameters are presented in table1.

Flowering parameters

Days to first flowering

Significantly earliest flowering was observed in the plant spacing of S_3-1.0m x 0.75m with minimum days for first flowering at 78.33 days after sowing. It was followed by the treatment S_4-1.0m x 1.0m in 84 days after sowing. Maximum days 96.66 required for first flowering was observed in the plant spacing S_6-1.5m x 0.75m which was at par with the spacing S_1-0.75m x 0.75m and S_2-1.0m x 0.5m.It is observed that earliest flowering was recorded in the plant spacing S_3-1.0m x 0.75m followed by S_4-1.0m x 1.0m which is optimum spacing instead of S_1 (narrower spacing) or S_7 (wider spacing). This might have occurred due to the fact that pole type lima beans are very vigorous and too close planting results in excessive vegetative growth but poor reproductive growth whereas wider spacing results in more horizontal growth and plant canopy area due to less population density and competition for space, light, nutrients and moisture. The present results are contradictory to the findings of Kumar *et al.*, (1997), Srikanth *et al.*, (2008) who reported that the effect of spacing for days to flower initiation was non-significant.

Days to 50% flowering

The significant differences were observed for days required to 50% flowering as influenced by different plant spacings of lima bean. These findings are similar to that of days required for first flowering. This might be due to optimum vegetative growth of lima bean planted at optimum plant spacing of S_3-1.0m x 0.75 m resulting in early flowering as compared to that of closely and wider spaced plants. However Shrikanth *et al.,* (2008) observed non-significant results for 50% flowering in lima bean.

Inflorescence per plant

Inflorescence per plant may be due to resulting in maximum number of inflorescence per plant in the spacing S_3-1.0m × 0.75 m whereas inflorescence in the too closer and wider spacing was less because of more vertical and horizontal growth respectively. This resulted in excessive vine growth and thus reducing flowering and yields. This finding is supported by Anonymous (2016).

Flowers per inflorescence

Flowers per inflorescence was observed maximum (6.20) in spacing S_3-1.0m × 0.75m followed by S_4-1.0m x 1.0 m. However minimum flowers per inflorescence (5.03) was obtained in spacing S_7 - 1.5m x 1.0 m. Flowers per inflorescence in the too closer and too wider spacing was less because of more vertical and horizontal growth. It results due to excessive vine growth and it reduces flowers per inflorescence. This is in support to the findings of Anonymous (2016).

Yield parameters

Number of pods per cluster

The significant differences were observed for number of pods per cluster as influenced by different plant spacing of lima bean. The number of pods per cluster (5.21) was found to be superior among all the treatment in spacing S_3-1.0m x 0.75m followed by S_4-1.0 m x 1.0 m and minimum in S_5-1.5m x 0.5m (3.25).The present findings confirms that optimum plant spacing is required for obtaining maximum number of pods per cluster.

Length of pod (cm)

The significant differences were observed in length of pod as influenced by different spacing significantly maximum length of pod (10.73cm) was observed in spacing S_3 - 1.0m × 0.75 m followed by spacing S_4-1.0m x 1.0 m (9.68cm) and minimum pod length occurred in spacing S_5 -1.5m x 0.5m. The present findings suggests that pod length was reduced with too closer and too wider spacing whereas it was increased in the plant spacing of 1.0m x 0.75m which might be due to optimum vegetative growth and uptake of nutrients and moisture from soil. In contradictory Achakzai and Panizai (2007) has reported maximum pod length at narrower row spacing of 25cm in mash bean while Joshi and Rahewar (2014) in wider row spacing of 60cm in Indian bean however the results were non-significant.

Table.1 Flowering, yield and quality parameters as influenced by plant spacing

Treatments	Days to first flowering	Days to 50% flowering	Infloroscence /plant	Flowers /inflorescence	No. of pods/ Cluster	Length of pod (cm)	Width of pod (cm)	Wt. of dry seed (g)	Wt. of dry seed /pod(g)	Wt. of 100 dry seeds(g)	Seed Yield/ plant (g)	Seed yield / ha (q/ha)	Seed protein content (%)
S_1-0.75m x 0.75m	96.00	110.00	20.60	5.63	3.51	7.74	1.95	0.98	2.96	81.33	120.00	21.33	16(4.12)
S_2-1.0m x 0.5m	95.00	107.33	20.06	5.20	3.45	7.81	2.00	0.99	2.83	79.33	112.00	22.40	16.50 (4.18)
S_3-1.0m x 0.75m	78.33	100.00	32.46	6.20	5.21	10.73	2.27	1.72	4.84	91.66	251.66	33.50	17 (4.24)
S_4-1.0mx 1.0m	84.00	102.94	29.13	5.96	3.76	9.68	2.08	1.34	3.96	87.00	248.00	27.00	17.33 (4.28)
S_5-1.5m x 0.5m	91.00	104.00	20.00	5.46	3.25	7.62	1.93	1.21	3.54	82.33	165.00	20.00	16.33 (4.16)
S_6-1.5m x 0.75m	96.66	118.00	20.46	5.80	3.50	8.34	1.98	1.11	3.34	84.66	224.33	19.93	16.33 (4.16)
S_7-1.5m x 1.0m	92.00	106.00	19.26	5.03	3.46	8.07	1.96	0.90	2.73	77.66	220.66	14.71	16.66 (4.20)
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig	Sig.	NS
SE(m)±	0.60	0.78	0.62	0.06	0.09	0.36	0.04	0.07	0.20	0.85	1.72	0.81	0.042
CD at 5%	1.87	2.43	1.93	0.19	0.30	1.01	0.12	0.24	0.64	2.66	4.82	2.26	-

Width of pod (cm)

Width of pod as influenced by different spacing were found to be significantly maximum width of pod (2.27cm) was observed in spacing S_3-1.0m x 0.75 m followed by S_4-1.0m x 1.0 m (2.08) whereas minimum (1.94) width of pod occurred in spacing S_5 -1.5m x 0.5 m. The results are in agreement with Samnotra *et al.,* (1998) who reported significant effect of row spacing on width of pod.

Weight of dry seed (g)

Weight of dry seed (g) due to different spacing was found to be statistically significant. Weight of dry seed (1.72g) was found significantly superior in S_3-1.0m x 0.75m followed by (1.34 g) in S_4-1.0m x 1.0m and minimum (0.90g) in plant spacing S_7-1.5m x 1.0m.The results revealed that the optimum plant spacing of S_3-1.0m x 0.75m recorded highest dry weight of seed which may be attributed due to more weight of fresh seeds in S_3.

Weight of dry seed per pod (g)

Weight of dry seed per pod (g) as influenced by different spacing was found to be significant. Weight of dry seed per pod (4.84) was found to be significantly superior among all the treatment in S_3-1.0m x 0.75m (4.83) followed by (3.96) in S_4-1.0m x 1.0m and minimum (2.73) in S_7-1.5m x 1.0m.The results revealed that weight of dry seed per pod was increased in optimum plant spacing and not in too closer or wider spacing. This might be due to the optimum vegetative growth and reproductive parameters occurred in this spacing, which resulted in optimum plant population of lima bean with better utilization of space, light, moisture and nutrients. However it is not in agreement with the findings of Akhtar *et al.,* (2012) who found non-significant effect of row spacing on number of seed**.**

Weight of 100 dry seeds (g)

Weight of 100 dry seeds (g) as influenced by different spacing was found to be significant. Weight of 100 dry seeds (91.66g) was significantly superior among all the treatment in S_3-1.0m x 0.75m followed by (87g) in S_4-1.0m x 1.0m and minimum (77.66g) in S_7 -1.5m x 1.0mIt is well evident that weight of 100 dry seeds decreased in too closer and wider plant spacings whereas it was maximum at a plant spacing of S_3-1.0m x 0.75m.This might be due to the increased dry seed weight of lima bean in the same treatment. Similar results were reported by Prashanth *et al.,* (2006).

Seed yield per plant (g)

Significant differences were observed for seed yield per plant as influenced by different spacing. Significantly maximum seed yield per plant (251.66 g) was found in the treatment S_3-1.0m x 0.75m which was at par (248g) in S_4-1.0m x 1.0m and minimum (112g) in S_2-1.0m x 0.5m.The present results revealed that seed yield per plant was reduced in closer and wider spacing and maximum in optimum plant spacing of 1.0m x 0.75m. This might be due to optimum vegetative and reproductive growth of plants spaced at 1.0m x 0.75m which is reflected in terms of more number of inflorescence per plant, flowers per inflorescence, weight of seeds and pods per plant.

Seed yield per hectare (q)

Seed yield per hectare (q) as influenced by different spacing was found to be significant. The seed yield per hectare (33.5q) was found significantly superior in the treatment S_3-1.0m x 0.75m followed by

(27q) in S_4-1.0m x 1.0m and minimum (14.71q) in S_7-1.5m x 1.0m.It is well evident from the present findings that seed yield per hectare was maximum in the optimum plant spacing than closer and wider spacing. Maximum seed yield per hectare may be attributed due to the optimum vegetative and reproductive growth of plants spaced at 1.0m x 0.75m with superior flowering and seed parameters. This is in confirmation with Achakzai and Panizai (2007) who reported positive correlations of number of pods per plant and seed yield per plant with grain yield per hectare. Similar findings were reported by Pilbeam *et al.,* (1989) who stated that greater yields were associated with heavier seeds and more seeds per pod. However too closer spacing resulted in less yield per hectare. Besides poor flowering parameters, more incidences of pest and diseases in dense canopy of closely spaced plants may have resulted in low yield per hectare. Whereas low yield is observed in widely spaced plants because of less number of plants per hectare.

Quality parameter

Seed protein content (%)

Seed protein content was not significantly influenced by different spacing. However maximum seed protein content was obtained from the plant spacing of S_4 – 1.0 m x 1.0 m while minimum in S_1 -0.75m x 0.75m.This is in confirmation with the findings of Singh *et al.*, (1971), Habibzadeh *et al.*, (2002) who reported non-significant effect on seed protein.

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